What is Claimed is:

1. An optical wave power control device for varying the transmitted power at at least one optical frequency (i.e., optical carrier wave) on at least one optical wave power transmission member, comprising:

an optical wave transmission member configured for propagating optical power at at least one optical frequency;

at least one circulating mode resonator, said resonator disposed to couple wave power from and/or to said transmission member; and,

at least one controller, each said controller in operative relationship with a different one of said resonators so as to vary the effect of said resonator on the optical power in said wave transmission member in response to a control signal.

2. An optical power control device as set forth in claim 1 above, wherein said controller includes a interferometer in the optical path of said resonator, and said control signal is an external signal.

3. An optical wave power control device as set forth in claim 2 above wherein said resonator and said transmission member introduce losses such that said resonator is overcoupled and the loss induced by said controller attains critical coupling.

4. An optical wave power control device as set forth in claim 1 above, wherein actuation of said interferometer by said control signal maintains the loss per round trip of recirculating modes at the resonant frequency in a critical coupling regime.

5. An optical power control device as set forth in claim 1 above, wherein said resonator includes an enclosed cavity having an equatorial periphery with a diameter of less than approximately 1000 microns, said cavity being optically coupled to said transmission member and which circulates resonant modes equatorially.

6. An optical power control device as set forth in claim 5 above, wherein said resonator has a Q that is selected in accordance with the desired wavelength and bandwidth of said transmission that is being modified.

7. An optical power control device as set forth in claim 5 above where the frequency separation of the modes of said resonator is selected in accordance with the spectral extent spanned by the frequencies propagating in said transmission member.

8. An optical power control device as set forth in claim 7 above wherein the mode frequency separation of said resonator is greater than 200 GHz.

9. An optical power control device as set forth in claim 6 above, where the circumferential periphery diametral dimension of said resonator is less than about 100 microns and has a Q of the order of 20,000 in the 1550nm telecommunications band.

10. An optical power control device as set forth in claim 1 above, wherein said transmission member is a planar waveguide and said resonator has the geometric shape of a ring.

11. An optical power control device as set forth in claim 1 above, wherein the device operates as a modulator responsive to a given optical frequency.

12. An optical power control device as set forth in claim 1 above, wherein the device operates as a switch responsive to a given optical frequency.

13. A control device as set forth in claim 1 above, wherein at least one of said controllers includes an interferometer coupled to the optical path of said resonator and responsive to a control signal for variably modifying said resonator losses.

14. A control device as set forth in claim 13 above, wherein said control signal is an externally applied differential voltage.

15. A control device as set forth in claim 13 above, wherein said control signal is an externally applied differential current.

16. A control device as set forth in claim 13 above, wherein said control signal is an externally applied optical signal.

17. A control device as set forth in claim 1 above, wherein said at least one said controller includes an interferometer coupled to the optical path of said resonator and responsive to a control signal for variably modifying the coupling between said wave power transmission member and said resonator.

18. A control device as set forth in claim 17 above, wherein said control signal is an externally applied differential voltage.

19. A control device as set forth in claim 17 above, wherein said control signal is an externally applied differential current.

20. A control device as set forth in claim 17 above, wherein said control signal is an externally applied optical signal.

21. A control device as set forth in claim 1 above, wherein at least one of said controllers includes one or more interferometers in optical communication with at least one of said resonators, and a controllable electrical field applied to the interferometers to modify the power communicated from said resonator to said wave transmission member.

22. A control device as set forth in claim 1 above, wherein at least one of said controllers comprises one or more interferometers in optical communication with at least one of said resonators, and means for applying a controllable optical signal to the interferometers to modify the power communicated from said resonator to said wave transmission member.

23. A control device as set forth in claim 1 above, wherein the frequency separation between the modes of said resonator is selected in accordance with the spectral extent spanned by the frequencies propagating in said transmission member.

24. A control device as set forth in claim 1 above, wherein the Q of said resonator is established at a level determined by the wavelength and data rate/signal bandwidth of said control signal.

25. A control device as set forth in claim 1 above, wherein said resonator has a Q of the order of 20,000 in the 1550nm telecommunications band, said resonator has a diameter of less than 100 microns, and said control signal has a data rate of the order of 10 Gigabits per second.

26. A control device as set forth in claim 1 above, wherein said optical wave transmission member propagates a number of different frequencies and wherein the device includes a plurality of resonators, each resonant at a different one of the propagated frequencies and in coupling relation to said wave transmission member, and a plurality of controllers, each disposed in relation to a different one of said resonators and controlling said resonator round trip loss thereat so as to vary power transmission at a selected frequency.

27. An optical power control device in accordance with claim 1 above, wherein said controller introduces loss variations between substantially full and substantially zero transmission such that at least one optical frequency is switched on or off.

28. An optical power control device in accordance with claim 1 above, wherein said wave transmission member propagates a number of different frequencies in a wavelength division multiplexed mode, wherein the device includes multiple resonators, each resonant at a different frequency, and wherein said controller selectively switches (i.e., blocks or admits) frequencies out of the multiplexed signals by varying transmission at each resonator.

29. An optical power control device in accordance with claim 1 above, wherein a plurality of resonators and associated controllers are disposed in-line with said wave transmission member, each resonator and associated controllers comprising a modulator operating at a different optical frequency in a set of optical frequencies, and further including a plurality of laser sources that are in-line in said wave transmission member and transmitting different frequencies of the set in a downstream direction on said transmission member, and in which the modulator for each given frequency is downstream of the laser source for that frequency.

30. An optical power control device in accordance with claim 29 wherein the device further includes optical pump means for the lasers coupled into said transmission member.

31. An optical wave power control device as set forth in claim 1 above, and further comprising a second wave transmission member in coupling relation to said resonator.

32. An optical wave power control device as set forth in claim 31 above, wherein said two transmission members couple to substantially the same resonator modes, and where said resonator round trip loss associated with said resonator to transmission member couplings establishes near critical coupling between said resonator modes and each said transmission member.

33. An optical power control device as set forth in claim 31 above, including an interferometer in the optical path of said resonator and responsive to an external control signal to vary the loss of said resonator.

34. An optical power control device as set forth in claim 33 above, wherein the external control signal includes applying an electric current, voltage and/or an optical signal to said interferometer.

35. An optical power control device as set forth in Claim 1 above, wherein the device includes a second transmission member optically coupled to said resonator, and said resonator coupling with said second member is varied by said controller.

36. An optical power control device as set forth in claim 35 wherein the second member is a waveguide and the means for varying said power coupling includes an interferometer in the optical path of said resonator.

37. An optical power control device as set forth claim 36 wherein said interferometer is controlled by application of a variable voltage.

38. An optical power control device as set forth claim 36 wherein said interferometer is controlled by application of a variable current.

39. An optical power control device as set forth claim 36 wherein said interferometer is controlled by application of an optical signal to said interferometer.

40. An optical power control device as set forth in claim 36 above, wherein at least one said controller varies a property associated with resonator round-trip loss associated with said resonator to member coupling while other sources of resonator round-trip loss are substantially fixed.

41. An optical power control device as set forth in claim 40 above, wherein said round-trip loss is varied by varying said resonator-to-member coupling amplitude K'.

42. An optical power control device as set forth in claim 41 above, wherein the coupling amplitude is varied by electrooptic means.

43. An optical power control device as set forth in claim 41 above, wherein the coupling amplitude is varied by optical means.

44. An optical power control device as set forth in claim 41 wherein the coupling amplitude is varied by application of a variable voltage to an interferometer in the optical path of said resonator.

45. An optical power control device as set forth in claim 41 wherein the coupling amplitude is varied by application of a variable current to an interferometer in the optical path of said resonator.

46. An optical power control device as set forth in claim 41 wherein the coupling amplitude is varied by application of an optical signal to an interferometer in the optical path of said resonator.

47. An optical power control device as set forth in claim 32 above, wherein the property that is varied is said resonator loss, α.

48. An optical power control device as set forth in claim 47 above, wherein said resonator loss is varied by electrooptic means.

49. An optical power control device as set forth in claim 47 above, wherein said resonator loss is varied by optical means.

50. An optical power control device as set forth in claim 41 wherein said resonator loss is varied by application of an optical signal to an interferometer in the optical path of said resonator.

51. An optical power control device as set forth in claim 41 wherein said resonator loss is varied by application of a variable voltage to an interferometer in the optical path of said resonator.

52. An optical power control device as set forth in claim 41 wherein said resonator loss is varied by application of a variable current to an interferometer in the optical path of said resonator.

53. An optical power control device as set forth in claim 40 above, wherein the device comprises means for varying the component of round-trip negative resonator loss (optical gain) separately from said resonator loss associated with the member couplings.

54. An optical power control device as set forth in claim 53 above, wherein said resonator comprises means for providing optical gain.

55. An optical power control device as set forth in claim 53 above, wherein the optical gain induces overcoupling.

56. An optical power control device as set forth in claim 35 above wherein the loss associated with said controller induces undercoupling.

57. An optical wave power control device as set forth in claim 1 above, wherein the at least one resonator comprises at least two resonators, each resonant at a like frequency and each disposed at a different quadrant about the length of said wave transmission member.

58. An optical power control device, comprising:

a continuous length of an optical waveguide arranged for transporting at least one optical wave;

at least one high Q optical wave recirculating device in communication with the waveguide for exchanging wave power therewith, and

a wave power controller in optical communication with the at least one circulating mode device for varying the wave power returned to said waveguide from said optical recirculating device, said wave power controller including at least one interferometer in the optical path of said recirculating device, and which interferometer is arranged to respond to a control signal.

59. An optical power control device as set forth in claim 58 above, wherein said control signal is a variable voltage which causes said interferometer to vary said resonator loss, α.

60. An optical power control device as set forth in claim 58 above, wherein said control signal is a variable current which causes said interferometer to vary said resonator loss, α.

61. An optical power control device as set forth in claim 58 above, wherein said control signal is an optical signal which causes said interferometer to vary said resonator loss, α.

62. An optical power control device as set forth in claim 58 above, wherein said control signal is a variable voltage which causes said interferometer to vary said resonator-to-member coupling amplitude K'.

63. An optical power control device as set forth in claim 58 above, wherein said control signal is a variable current which causes said interferometer to vary said resonator-to-member coupling amplitude K'.

64. An optical power control device as set forth in claim 58 above, wherein said control signal is an optical signal which causes said interferometer to vary said resonator-to-member coupling amplitude K'.

65. An optical power control device as set forth in claim 58 above, wherein said recirculating device is a member of the class of wave power resonators characterized as whispering gallery

mode devices and comprising rings, and wherein said wave power propagating member is of the class comprising optical fiber waveguides.

66. An optical power control device as set forth in claim 58 above, wherein said recirculating device is a member of the class of wave power resonators characterized as whispering gallery mode devices and comprising rings, and wherein said wave power propagating member is of the class comprising planar optical waveguides.

67. An optical power control device as set forth in claim 58 above, wherein said wave power control varies said returned wave power between said recirculating device and said propagating member either from overcoupled to critically coupled or from critically coupled to undercoupled conditions.

68. An optical wave transmission control for in-line variation of power transmission on an optical waveguide, comprising:

a low loss optical wave power recirculating device having a periphery adjacent to the optical waveguide in a relation to couple wave power therefrom, said recirculating device also returning wave power to the optical waveguide, and

a variable coupling device operating with said recirculating device for varying the power returned to the optical waveguide from said recirculating device to vary power transmission on the optical waveguide without introducing discontinuities into the waveguide.

69. An optical wave transmission control as set forth in claim 68 wherein said variable coupling device introduces losses per recirculation round trip to either establish critical coupling of a previously overcoupled resonator or establish undercoupling of a previously critically coupled resonator.

70. An optical wave transmission control as set forth in claim 68 above, wherein said variable coupling device interacts with said recirculating wave to interfere with a portion of the recirculating wave energy per round trip.

71. The method of modifying the power level of a mono-wavelength signal in an optical waveguide comprising the steps of:

transferring a part of the power transmitted along the waveguide into a whispering gallery mode resonant at the transmitted wavelength;

returning power to the optical waveguide from circulating mode resonator; and,

introducing a controllable loss in the power of said resonator to modify the power level in the transmitted signal in the waveguide.

72. A method as set forth in claim 71 above, wherein the intrinsic losses in transferring power and in said resonator operation are insufficient to extinguish the waveguide power level and the controllable loss is varied in a range greater than the intrinsic losses.

73. A method as set forth in claim 72 above, wherein the introduced controllable loss is varied between a critical coupling level wherein the waveguide transmitted power is at a minimum and a level at which the waveguide transmitted power is substantially unattenuated.

74. A method as set forth in claim 71 above, including the added steps of:

actuating an interferometer in the optical path of said resonator by applying a variable voltage to said interferometer to cause said controllable loss in power.

75. A method as set forth in claim 71 above, including the added steps of:

actuating an interferometer in the optical path of the resonator by applying a variable current to said interferometer to cause said controllable loss in power.

76. A method as set forth in claim 71 above, including the added steps of:

actuating an interferometer in the optical path of the resonator by applying an optical signal to said interferometer to cause said controllable loss in power.

77. A method as set forth in claim 74 above, wherein the waveguide transmitted power is non-polarized and wherein the step of introducing the controllable loss includes establishing at least two resonators in which power circulates in planes that are orthogonally disposed relative to each other.

78. A method of modulating or switching light at a single wavelength along a continuous optical waveguide comprising the steps of:

propagating a guided part of the optical power along the waveguide;

transferring a portion of the power that is inside the waveguide into a high Q recirculating path;

returning power from the recirculating path to the optical waveguide; and

introducing loss to the recirculating power in controlled fashion to modulate the power propagated along the waveguide.

79. A method of modulating or switching light at a single wavelength along a continuous optical waveguide as set forth in claim 78 above, wherein said loss is controlled by an interferometer in the optical path of said recirculating path.

80. A method of modulating or switching light at a single wavelength along a continuous optical waveguide as set forth in claim 79 above, wherein said interferometer is controlled by the application of a variable voltage to said interferometer.

81. A method of modulating or switching light at a single wavelength along a continuous optical waveguide as set forth in claim 79 above, wherein said interferometer is controlled by the application of a variable current to said interferometer.

82. A method of modulating or switching light at a single wavelength along a continuous optical waveguide as set forth in claim 79 above, wherein said interferometer is controlled by the application of an optical signal to said interferometer.

83. A method as set forth in claim 80, above, wherein the optical power transmitted comprises a single wavelength signal and wherein the step of recirculating is resonant at that wavelength.

84. A method as set forth in claim 80 above, wherein the optical power transmission comprises at least two different wavelength signals and the interferometer controls at least one of the different wavelength signals.

85. A modulator for use with an optical fiber transmission system, comprising:

an optical fiber;

an optical resonator in communication with said optical fiber for said transmission of optical power from said fiber to said resonator and back again to said fiber, said resonator being configured to be resonant and to generate internal recirculating modes at the selected nominal frequency of the optical power being transmitted by said waveguide; and,

a loss controller including an interferometer in the optical path of said resonator, for introducing a loss as the modes recirculate to thereby either establish critical coupling of a previously overcoupled resonator or establish undercoupling of a previously critically coupled resonator.

86. A modulator as set forth in claim 85 above, wherein said resonator comprises a whispering gallery mode device.

87. A modulator as set forth in claim 85 above, wherein said resonator comprises a ring, and wherein the Q of said resonator is determined by sizing said resonator in accordance with the spectral linewidth required for a data rate to be used in transmission.

88. A system for generating and controlling multiple optical signals of different wavelengths on a single optical waveguide capable of propagating multiple wavelengths within a chosen bandwidth, comprising:

an optical waveguide including at least two in-waveguide optical power sources operating at different wavelengths in the chosen bandwidth;

at least two optical resonators, each being resonant at a different one of the wavelengths in the chosen bandwidth and each being disposed in coupling relation to a different integral length of said optical waveguide and coupled thereto; and,

a control system optically coupled to each of said resonators for controlling power loss thereat, whereby propagated power at different wavelengths is separately controlled in the single optical waveguide.

89. A system as set forth in claim 88 wherein said control system includes an interferometer, said interferometer having a variable voltage applied thereto to control said optical power in said waveguide for at least one of the wavelengths in said optical waveguide.

90. A system as set forth in claim 88 wherein said control system includes an interferometer, said interferometer having a variable current applied thereto to control said optical power in said waveguide for at least one of the wavelengths in said optical waveguide.

91. A system as set forth in claim 88 wherein said control system includes an interferometer, said interferometer having an optical signal applied thereto to control said optical power in said waveguide for at least one of the wavelengths in said optical waveguide.

92. A system as set forth in claim 88 wherein said control system includes an interferometer in the optical path of each of said resonators, said interferometer having a variable voltage applied thereto to independently control said optical power in said waveguide at each of the wavelengths in said optical waveguide.

93. A system as set forth in claim 88 wherein said control system includes an interferometer in the optical path of each of said resonators, said interferometer having a variable current applied thereto to independently control said optical power in said waveguide at each of the wavelengths in said optical waveguide.

94. A system as set forth in claim 88 wherein said control system includes an interferometer in the optical path of each of said resonators, said interferometer having an optical signal applied thereto to independently control said optical power in said waveguide at each of the wavelengths in said optical waveguide.

95. In an optical system for introducing a variable optical power transmission in an optical waveguide in communication with an optical wave resonator, the improvement comprising:

including an interferometer responsive to an external stimulus in the optical path of said resonator for controlling the coupling between the waveguide and said resonator, K'.

96. The improvement set forth in claim 95 wherein said external stimulus is a variable voltage.

97. The improvement set forth in claim 95 wherein said external stimulus is a variable current.

98. The improvement set forth in claim 95 wherein said external stimulus is an optical signal.

99. A. In an optical system for introducing a variable optical power transmission in an optical waveguide in communication with an optical wave resonator, the improvement comprising:

including an interferometer responsive to an external stimulus in the optical path of said resonator for controlling the internal loss of said resonator, α.

100. The improvement set forth in claim 99 wherein said external stimulus is a variable voltage.

101. The improvement set forth in claim 99 wherein said external stimulus is a variable current.

102. The improvement set forth in claim 99 wherein said external stimulus is an optical signal.

103. An optical wave power control device for varying the transmitted power at at least one optical frequency (i.e., optical carrier wave) on an optical wave power transmission member comprising:

An optical wave transmission member configured for propagating and guiding optical power at at least one optical frequency;

At least one optical wave resonator disposed in coupling relation to said transmission member, positioned to couple wave power from and to said member, and in frequency resonance with a selected optical wave propagating on said transmission member;

At least one controller, each in operative relationship to a different one of said resonators, for varying a property of said respective resonator such that the optical wave transmitted in said wave transmission member is varied in power level.

104. An optical wave power control device as set forth in claim 103 above, wherein said property that is varied is the component of round-trip resonator loss that is distinct from said resonator loss associated with said member coupling.

105. An optical wave power control device as set forth in claim 104 above, wherein said loss is varied by varying the internal loss of said resonator.

106. An optical wave power control device as set forth in claim 104, wherein said loss is varied by an interferometer which is actuated by applying a differential voltage to said interferometer.

107. An optical wave power control device as set forth in claim 104, wherein said loss is varied by an interferometer which is actuated by applying a differential current to said interferometer.

108. An optical wave power control device as set forth in claim 104, wherein said loss is varied by an interferometer which is actuated by applying an optical signal to said interferometer.

109. An optical wave power control device as set forth in claim 104 above, wherein said loss is varied by varying the coupling of resonator mode power into another member or structure.

110. A variable coupling as set forth in claim 109 wherein the structure is an interferometer in the optical path of said resonator, whose phase matching is varied to control power coupling.

111. A waveguide as set forth in claim 110 wherein said phase matching is varied by applying a Voltage to said interferometer.

112. A waveguide as set forth in claim 110 wherein said phase matching is varied by applying a current to said interferometer.

113. A waveguide as set forth in claim 110 wherein said phase matching is varied by applying an optical signal to said interferometer.

114. An optical wave power control device as set forth in claim 103 above, wherein said property that is varied is the component of round-trip resonator loss associated with said resonator to member coupling and with other sources of resonator round-trip loss fixed.

115. An optical wave power control device as set forth in claim 114 above, wherein said loss is varied by varying said resonator-to-member coupling amplitude K'.

116. An optical wave power control device as set forth in claim 103 above, wherein said property that is varied is the component of round-trip negative resonator loss (optical gain) that is distinct from said resonator loss associated with said member coupling.

117. An optical wave power control device as set forth in claim 116 wherein said optical gain is provided by said resonator.

118. An optical wave power control device as set forth in claim 104 above wherein said resonator and member introduce components of round-trip resonator loss such that said resonator is over-coupled and the loss associated with said controller induces critical coupling.

119. An optical wave power control device as set forth in claim 104 above wherein said resonator and member introduce components of round-trip resonator loss such that said resonator is critically coupled and the loss associated with said controller induces under coupling.

120. An optical wave power control device as set forth in claim 114 above wherein said resonator and member introduce components of round-trip resonator loss such that said resonator is over-coupled and the loss associated with said controller is varied to induce critical coupling.

121. An optical wave power control device as set forth in claim 114 above wherein said resonator and member introduce components of round-trip resonator loss such that said resonator is critically coupled and the loss associated with said controller is varied to induce under coupling.

122. An optical wave power control device as set forth in claim 116 above wherein said resonator and member introduce components of round-trip resonator loss such that said resonator is critically coupled and the optical gain associated with said controller induces over coupling.

123. An optical wave power control device as set forth in claim 114 above wherein said resonator and member introduce components of round-trip resonator loss such that said resonator is under coupled and the optical gain associated with said controller induces critical coupling.

124. An optical power control device as set forth in claim 103 above, wherein said optical wave transmission member propagates a number of different frequencies and wherein said device includes a plurality of resonators, each resonant at a different one of said propagated frequencies and in coupling relation to said wave transmission member, and a plurality of controllers, each disposed in relation to a different one of said resonators and controlling a property of said resonator thereat so as to vary power transmission at a selected frequency.

125. An optical power control device in accordance with claim 103 above, wherein a plurality of resonators and associated controllers are disposed in-line with said wave transmission member, each resonator and associated controllers comprising a modulator operating at a different optical frequency in a set of optical frequencies, and further including a plurality of laser sources that are in-line in said wave transmission member and transmitting different frequencies of the set in a downstream direction on said transmission member, and in which said modulator for each given frequency is downstream of said laser source for that frequency.

126. A control device as set forth in claim 21 above, wherein the frequency separation between the modes of said resonator is selected in accordance with the spectral extent spanned by the frequencies propagating in said transmission member.

127. A control device as set forth in claim 22 above, wherein the frequency separation between the modes of said resonator is selected in accordance with the spectral extent spanned by the frequencies propagating in said transmission member.

128. A control device as set forth in claim 21 above, wherein the Q of said resonator is established at a level determined by the wavelength and data rate/signal bandwidth of said control signal.

129. A control device as set forth in claim 22 above, wherein the Q of said resonator is established at a level determined by the wavelength and data rate/signal bandwidth of said control signal.

130. A control device as set forth in claim 21 above, wherein said resonator has a Q of the order of 20,000 in the 1550nm telecommunications band, said resonator has a diameter of less than 100 microns, and said control signal has a data rate of the order of 10 Gigabits per second.

131. A control device as set forth in claim 22 above, wherein said resonator has a Q of the order of 20,000 in the 1550nm telecommunications band, said resonator has a diameter of less than 100 microns, and said control signal has a data rate of the order of 10 Gigabits per second.

132. A method as set forth in claim 75 above, wherein the waveguide transmitted power is non-polarized and wherein the step of introducing the controllable loss includes establishing at least two resonators in which power circulates in planes that are orthogonally disposed relative to each other.

133. A method as set forth in claim 76 above, wherein the waveguide transmitted power is non-polarized and wherein the step of introducing the controllable loss includes establishing at least two resonators in which power circulates in planes that are orthogonally disposed relative to each other.

134. A method as set forth in claim 81 above, wherein the optical power transmitted comprises a single wavelength signal and wherein the step of recirculating is resonant at that wavelength.

135. A method as set forth in claim 82, above, wherein the optical power transmitted comprises a single wavelength signal and wherein the step of recirculating is resonant at that wavelength.

136. A method as set forth in claim 81 above, wherein the optical power transmission comprises at least two different wavelength signals and the interferometer controls at least one of the different wavelength signals.

137. A method as set forth in claim 82 above, wherein the optical power transmission comprises at least two different wavelength signals and the interferometer controls at least one of the different wavelength signals.